

Midterm Exam

الرقم التسلسلي:

رقم التسجيل:

الاسم:

Instructions: Time 60 minutes. Open book and notes exam. No electronics. Please answer all problems in the space provided and limit your answer to the space provided. **No questions are allowed.**

Q1. It is required to write a proper interrupt service routine for a PIC16F84A microcontroller that has its "Port B interrupt on change" enabled. On interrupt, this routine should read the content of Port A, multiply it by 4, and save the result in memory location h'20'.

<6 marks>

Int_Routine

```

movwf  w_temp      ;Copy W to W_TEMP register
swapf  status,0    ;Swap status into W
movwf  status_temp ;Save status

movf   porta,0
movwf  h'20'
bcf    status,C
rlf    h'20',1
bcf    status,C
rlf    h'20',1

swapf  status_temp,0 ;Swap nibbles into W
movwf  status        ;Move W into STATUS register
swapf  w_temp,1      ;Swap nibbles in W_TEMP
swapf  w_temp,0      ;Swap nibbles in W_TEMP into W

bcf    intcon, rbif

retfie

```

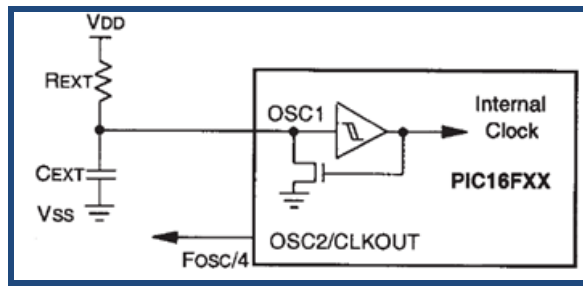
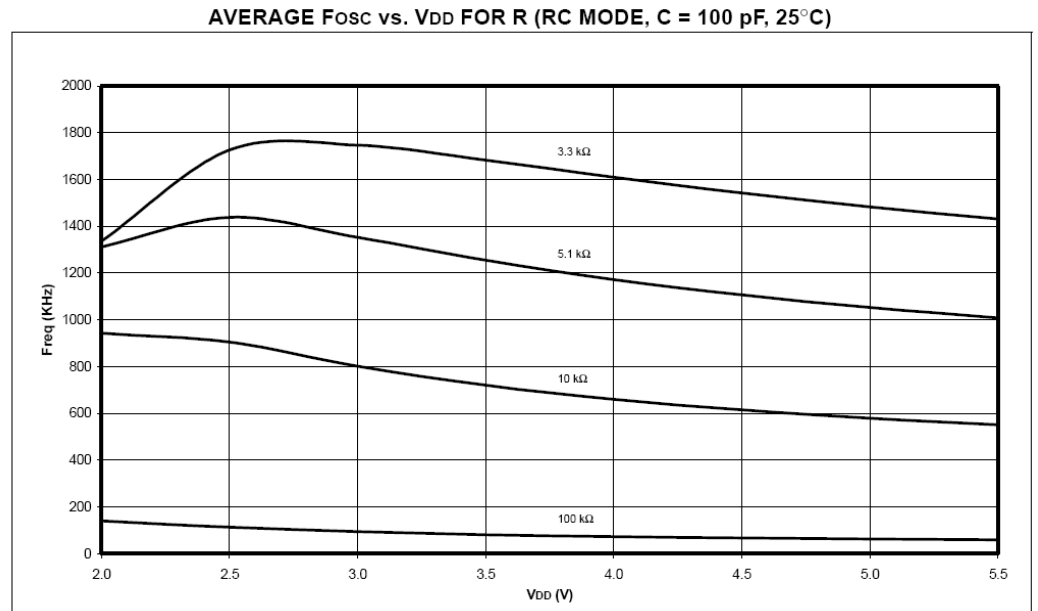
Q2. Why does the RS-232 standard have many wires in addition to TxD, RxD, and GND?

<2 marks>

To carry other signaling and handshaking signals.

Q3. Design an RC oscillator for a microcontroller that has the following characteristics and operates on a 3-volt power supply such that the oscillator frequency is 1.4 MHz. You must draw the oscillator circuit and specify the values of R and C.

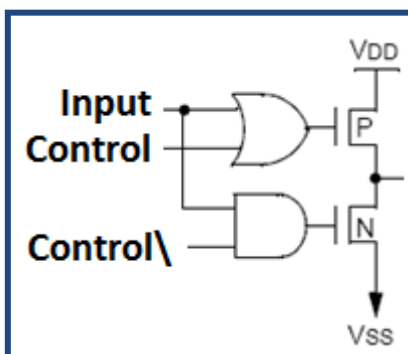
<4 marks>



$C_{EXT} = 100 \text{ pF}$
 $R_{EXT} = 5.1 \text{ K}\Omega$

Q4. Using field-effect transistors and basic logic gates only (AND, OR, NOT), design a circuit that has the characteristics shown in the following table. Note that this is the function of a tri-state inverter with active low control.

<4 marks>

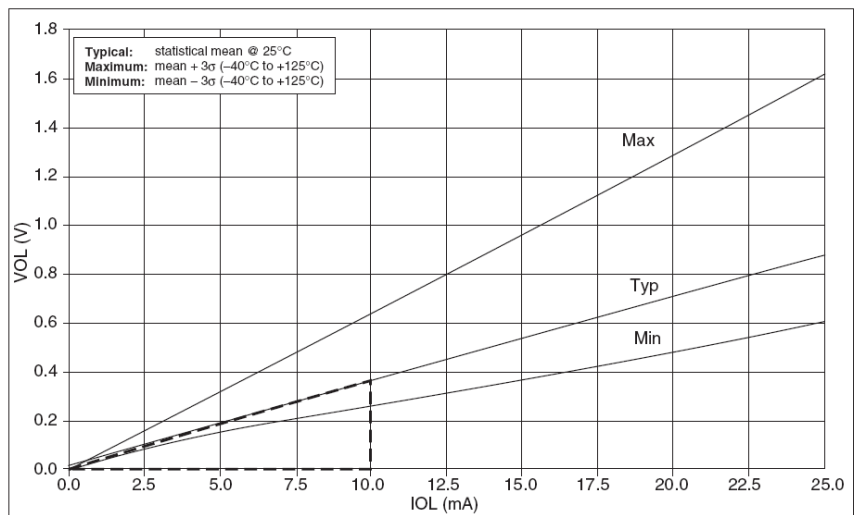
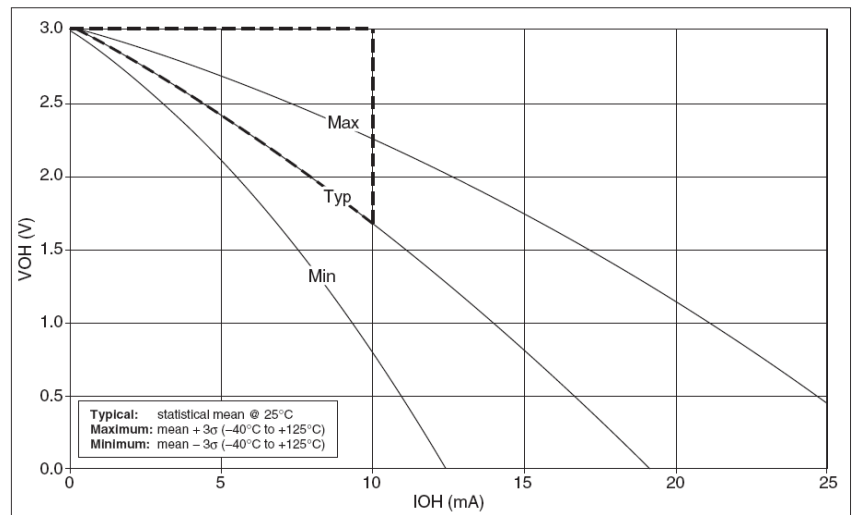
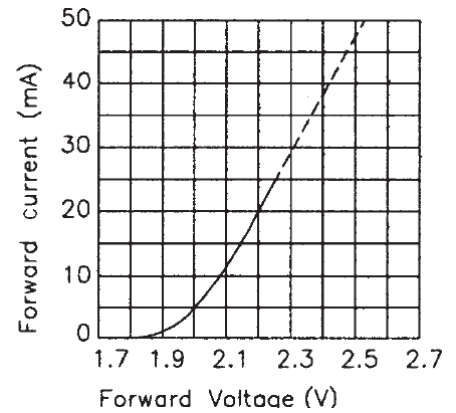
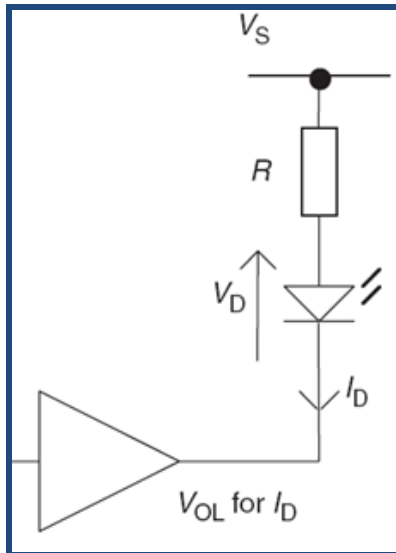


Control	Input	Output
0	0	1
0	1	0
1	0	Z
1	1	Z

Q5. A green LED has the voltage-current characteristics shown below and a typical operating current of 10 mA. It is required to connect it to a PIC microcontroller that has the output port characteristics shown below. *Note that the power supply is 3 volts.*

<6 marks>

- a) Draw a circuit that shows how the LED is connected to the microcontroller. *Remember that there are two options: current sourcing and current sinking. One of them is suitable.*



- b) If a current limiting resistor is used, what is its value in ohms? 56 Ω

$$R = (V_S - V_D - V_{OL}) / I_D = (3 - 2.08 - 0.36) / 10 \text{ mA} = 56 \Omega$$

Q6. How does the I²C bus accommodate multiple slave devices?

<2 marks>

Each device has a unique address and each transaction specifies the device address.

Q7. It is required to configure a PIC16F87XA microcontroller to perform asynchronous serial communications at 10,000 baud. What should be the contents of Register SPBRG and Bit BRGH to achieve this baud rate if $f_{osc} = 16 \text{ MHz}$? *Note that this is not a standard baud rate.*

<6 mark>

This is relatively a high baud rate, therefore BRGH = 1

Baud rate = $f_{osc} / (16 * (SPBRG + 1))$

$SPBRG = f_{osc} / (16 * \text{Baud rate}) - 1 = 16 \text{ MHz} / (16 * 10,000) - 1 = 100 - 1 = 99$

<Good Luck>